TITLE: METHOD AND APPARATUS FOR COLLECTING ATMOSPHERIC MOISTURE

TECHNICAL FIELD

This invention relates to a method and apparatus for collecting moisture from the atmosphere.

BACKGROUND ART

Water for communities is generally provided by means of large scale reticulation systems where water is collected in dams and distributed to users. Alternatively, users can themselves provide for water collection by means of tanks which collect water off roofs or other surfaces. Because of changing climatic conditions however, the reliability of conventional water supplies is lessening with the result that, in many communities, water restrictions are in place which limit the volumes of water which can be used or the manner of water use.

It is known that large quantities of water are contained in the atmosphere measured by humidity and various condensation systems in the past have been proposed for recovering water from the atmosphere. The systems which have been proposed however have not proved to be particularly efficient.

SUMMARY OF THE INVENTION

The present invention thus aims to provide improved methods and means for collecting water from the atmosphere. Other objects and advantages of the invention will become apparent from the following description.

The present invention thus provides in one preferred aspect a method of collecting water from the atmosphere, said method including:

arranging in an enclosed space a plurality of condenser members upon which moisture can condense;

exposing said enclosed space to said atmosphere;

providing flow means for increasing flow of air from said atmosphere through said enclosed space such that moisture in said atmosphere will condense upon said condenser members; and

providing collection means for collecting thus condensed said moisture.

The present invention provides in a further preferred aspect an apparatus for collecting water from the atmosphere, said apparatus including:

a body defining an enclosed space;

a plurality of downwardly angled condenser members within said enclosed space upon which moisture can condense, said enclosed space communicating with said atmosphere;

flow means for increasing flow of air from said atmosphere through said enclosed space; and

collection means for collecting thus condensed said moisture.

In a first form, the flow means for increasing air throughput is provided by an air exhaust extraction system. Suitably, the air exhaust extraction is undertaken at or near the base of the apparatus. Preferably the air exhaust extraction system includes one or more extractor fans. In isolated locations, the extractor fan/s may be powered directly by solar cells or from batteries charged by solar cells. Alternatively, where available, mains power may be used for driving the extractor fan/s.

Preferably, control means are provided to maximise air throughput as the humidity decreases. Such control means may function automatically and may comprise one or more humidity control switches which switch in one or more extractor fans as the humidity decreases. The control means may also be associated with temperature sensing means such that hot air is not passed through the system thereby reducing efficiency of operation of the condenser members.

Circulation means may also be provided for circulating cold air about or inside the apparatus. Cold air may be provided by an air-conditioning unit or other cold air source. Suitably, cold air is provided through a closed circuit system. The closed circuit system may comprise air ducts. The air ducts may be provided with heat exchange means to maximise heat transfer. The heat exchange means may comprise fins associated with the ducts. The circulation means may also be powered by solar cells or mains power.

Other means may also be provided to maximise flow of air. Such means may include a pressure means to alter pressure within the apparatus to increase air flow. Such pressure means may be a venturi.

The body of the apparatus may comprise a tank-like structure arranged in an upright configuration. In a further form, the enclosed space may be defined by an inclined body such that condensed water flows towards the lowermost end of the body for collection.

The condenser members may be arranged in any suitable orientation within the enclosed space. In one form, the condenser members may be arranged in rows. Condenser members in one row may be arranged in an opposite inclination of the condenser members in an adjacent row and the space between the rows may define a water flow passage such that water or moisture condensing on the condenser members will flow down the members and into the water flow passage for collection. The condenser members may be arranged in concentric rows.

In a further preferred aspect, the present invention provides an apparatus for collecting water from the atmosphere, said apparatus including:

a body defining an enclosed space;

a plurality of downwardly angled condenser members within said enclosed space upon which moisture may condense, said enclosed space communicating with said atmosphere; and

collection means for collecting thus condensed said moisture.

The condenser members may be of a conical or frusto-conical configuration.

The condenser members may be of circular cross section, of rectangular cross section or of any other suitable cross section.

In one form, the condenser members may be supported at spaced apart positions along respective central support members. The support members may be hollow to define flow passages through which moisture condensing on the condenser members may pass for collection.

Typically, the angle of inclination of the condenser members is 45 degrees, however this angle may be varied.

In yet a further preferred aspect, the present invention provides apparatus for collecting water from the atmosphere, said apparatus including:

an elongated chamber defining an enclosed space, said elongated chamber being inclined to the horizontal;

a plurality of condenser members upon which moisture can condense within said enclosed space;

an air inlet and an air outlet communicating said chamber with said atmosphere; and

collection means at the lower most end of said chamber for collecting condensed said moisture.

Preferably, cooling means are provided to cool the chamber and/or condenser members within the chamber. Such means may comprise cold air tubes within the chamber. The tubes may be located adjacent to the condenser members. Preferably, the cold air tubes are supplied with cold air from an air-

conditioning unit. The cold air tubes are preferably arranged within a closed circuit with the air-conditioning unit.

Preferably, to enhance condensation of moisture on the condenser members, they may be coated with zircon, zeolite or similar hydrophilic material.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate preferred embodiments of the invention wherein:

Fig. 1 is a schematic plan view of a first form of moisture collection apparatus according to an embodiment of the present invention;

Fig. 2 is a longitudinal sectional view of the apparatus of Fig. 1;

Fig. 3 is a schematic longitudinal sectional view of a further form of moisture collection apparatus according to an embodiment of the present invention;

Fig. 4 is a cross sectional view of the apparatus of Fig. 3;

Fig. 5 illustrates a typical configuration of condenser plates for the apparatus of Figs. 3 and 4;

Fig. 6 illustrates the manner in which the condenser plates are supported to a corrugated wall of the apparatus of Figs. 3 and 4;

Fig. 7 is a cross sectional view of the apparatus of Fig. 2 in an alternative configuration;

Fig. 8 is a sectional view of the wall of the apparatus of Fig. 3 showing air circulation ducts through the wall;

Fig. 9 is an enlarged view of one of the air circulation ducts and the manner in which air circulation in the apparatus is induced;

Fig. 10 is a schematic longitudinal sectional view of a further form of moisture collection apparatus according to an embodiment of the present invention;

Fig. 11 is a cross-sectional view of the apparatus of Fig. 10;

Fig. 12 illustrates a typical cooling tube for use in the apparatus of Fig. 10;

Fig. 13 is a schematic longitudinal sectional elevational view of a further form of moisture collection apparatus according to the invention;

Fig. 14 is a sectional view along line A-A of Fig. 13;

Fig. 15 is a sectional view along line B-B of Fig. 13 showing an alternative cross section;

Fig. 16 is a schematic view of the closed circuit cooling system for use in the moisture collection;

Figs. 17 and 18 are sectional views along lines C-C and D-D showing the air intake and air outlet of the air conditioning unit of the cooling system of Fig. 16;

Fig. 19 illustrates an alternative moisture collection unit employing conical condensers;

Figs. 20 to 22 illustrate alternative condenser configurations;

Figs. 23 and 24 illustrate the manner in which the units of Fig. 21 may be positioned within buildings of different configurations;

Fig. 25 illustrates the manner in which conical condensers can be manufactured;

Fig. 26 illustrates in exploded view an alternative condenser unit; and

Fig. 27 illustrates the condenser unit of Fig. 26 in longitudinal sectional view.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings and firstly to Fig. 1, there is illustrated apparatus 10 for collecting water from the atmosphere in accordance with a first embodiment of the invention. The apparatus 10 comprises a tank 11 of circular cross-section and having upper and lower air inlets 12 and 13 through the cylindrical wall 14 of the tank 11 to allow circulation of air and moisture carried thereby through the tank 11. The tank 11 is also preferably closed by a top lid. Supported within the tank 11 are a plurality of condenser plates 15

which are angled downwardly from the cylindrical wall 14 of the tank 11 but terminate short of the central axis of the tank 11 so as to defined a central water flow passage 16 for condensed water. The plates 15 may be of inverted frusto-conical form so as to extend fully around the interior of the wall 14 of the tank 11 or may be made up as a plurality of segment shaped elements as is illustrated in Fig. 1. The condenser plates 15 may be angled downwardly at any suitable angle such as 45° but this angle may be varied as desired.

In use, moisture carried by air circulating through the tank 11 by means of the air inlets 12 and 13 will condense on the condenser plates 15 and be directed by the inclined plates 15 towards the central flow passage 16 to collect in the bottom of the tank 11. A water outlet 17 is provided in the bottom of the tank 11 at a level such that some water remains in the tank 11 to act as a heat sink to reduce the temperature of the air within the tank 11 and promote further condensation. To improve moisture collection, air flow through the tank 11 may be enhanced by the use of a fan or other air flow inducing means.

Figs. 3 and 4 illustrate a further embodiment of water collection apparatus 18 according to the invention using the principles of the embodiment of Figs. 1 and 2. The apparatus 18 includes a generally cylindrical tank 19 having a side wall 20 which is preferably insulated for example as at 21 on opposite sides, preferably by Sisalation (RTM) or other insulating material. The side wall 20 supports a roof 22 which is externally concave. The roof 22 is constructed to have inner and outer skins 23 and 24 which defined air cavities 25 therebetween. The skins 23 and 24 may also be lined with an insulating material 26 such as Sisalation. A gutter 27 is provided at the periphery of the roof 22 to collect rain water in a conventional manner. The base 28 of the tank 19 is of a concave configuration and a central water outlet 29 is provided

in the base 28 for outlet of condensed water. The wall 20 may be extended so that the base 29 is supported above the ground and the base 29 can be supported by a support structure 30 extending between opposite sides of the tank 18. Air inlet/outlets 31 and 32 are provided adjacent the upper and lower ends of the wall 20, the air inlet/outlets 31 and 32 being formed as ducts penetrating the wall 20.

Arranged within the tank 19 are condenser assemblies 33 which are of similar configuration to that of Fig. 2 and comprise sets of condenser panels or plates 34 which are arranged in concentric rows in opposing sets and which occupy substantially the whole cross section of the tank 19. The panels or plates 34 in each row are inclined downwardly such that condensed moisture on the panels or plates 34 is directed to water flow passages 35 between sets of panels or plates 34 to collect on the base 28 for flow through the outlet 29.

The panels or plates 34 as also shown in Fig. 5 may be provided with flanges 36 which can be rivetted or otherwise fastened to the side wall 20 or battens 37 on the inside of the side wall 20. The condenser panels or plates 34 can be linked at their inner ends, for example, by being formed integrally.

The side walls 19, however, as shown in Fig. 6 may be formed of corrugated sheets and the condenser panels or plates 34 may be secured by rivetting to corrugations 37 of the sheets such that they are at the correct spacing.

The tank 19 is also provided with a central strut 39 which extends between the roof 22 and base 28, the strut 39 being extendable to expand the base and roof to allow central drainage of water.

The tank 19 as shown in Fig. 7 may also be of a square (or rectangular) cross-section. In this configuration, the downwardly inclined condenser panels or plates 34 are again arranged in sets in rows to occupy substantially the cross-section of the tank 19 and leaving water flow passages 35 between opposing sets of panels or plates 34.

To maximise water collection, extractor fans may be provide at the bottom outlets 31 of the tank 19. The extractor fans may be powered by solar panels either directly or through rechargeable batteries. Humidity switches may be provided on or adjacent to the tank 19 such that when the humidity drops below a certain level, such as 55% humidity, the switches switch on to start the extractor fans and exhaust dry cool air. Exhaustion of the dry cool air would result in further air from the atmosphere being introduced into the tank 19 and therefore not only increase the flow of air but maximise water collection. Further, the exhausted cool air could be recycled to pre-cool the subsequent incoming air from the atmosphere. This system may be interlocked with a temperature control system to ensure that no great quantity of hot air is introduced into the tank and thereby disrupt the water collection process.

A typical arrangement of extracting dry cool air from the tank 19 is shown in Figs. 8 and 9. In this arrangement, air exhaust passages 40 are formed through the tank wall 20 and in a somewhat tangential orientation. The passages 40 may be connected to a duct 41 in which air flow is induced by an extraction fan. Air forced through the duct 41 will create a low pressure in the outlet passages 40 and therefore draw air out of the tank 19. The orientation of the passages 40 will create a circular air flow in the tank 19 to maximise contact of the air flowing into the tank 19 with the condenser plates and therefore improve efficiency of moisture collection.

Fig. 10 illustrates a further embodiment of a water collection apparatus 42 according to the present invention which, in this embodiment, is in the form of an elongated chamber 43 of rectangular cross-section. The chamber 43 is supported in an inclined attitude and has an air inlet 44 at its upper end and an air outlet 45 at its lower end. The walls 46 of the chamber 43 are typically constructed to have insulating properties and for example may be formed of concrete or moulded from other materials.

The chamber 43 as shown in Fig. 11 contains sets of condenser plates or panels 47 of similar configuration to those in Figs. 1 to 3, the plates or panels 47 preferably extending the full length of the chamber 43 with the flow passages 48 between respective sets of panels or plates 47 directing collected moisture onto the bottom wall of the chamber 43 where it flows to the lower end of the chamber 43 for collection.

To promote the condensation of moisture on the condenser plates or panels 47, a series of cooling ducts 49 may be provided in a closed circuit, the ducts 49 extending along the length of the chamber 43 and adjacent the inner side of the walls 46 of the chamber 43 as shown more clearly in Fig. 11. Cold air is supplied to the ducts 49 from an air conditioning unit 50 mounted to the lower end of the chamber 43 arranged in a closed circuit with the ducts 49 such that cold air is pumped through the ducts 49 and returned to the air conditioning unit 51 for re-cooling. The closed circuit cooling system ensures that the cooling system does not need cleaning, that maximum cooling efficiency is achieved and that the risks of diseases such as legionnaires disease is minimal. To further enhance the cooling effect, the cooling ducts 49 as shown in Fig. 12 may be provided with fins 52 arranged helically or in any other orientation relative to the ducts 49 to increase the surface area for cooling.

Referring now to Fig. 13, there is illustrated a further embodiment of a water collection apparatus 53 according to the present invention which is similar to the embodiment of Figs. 10 and 11. The apparatus 53 includes an elongated chamber 54 which is inclined to the horizontal and which, as illustrated in Figs. 14 and 15, may be of a square cross-section, a circular cross-section or of any other suitable cross-sectional shape. The chamber 54 may be moulded from concrete or any other settable material, plastics or any other material.

An air conditioning unit 55 is located at one end of the chamber 54 and a plurality of interconnected air supply ducts and air return ducts 56 are provided along the inner walls of the chamber 54, in the embodiment of Fig. 14 along the top and side walls, and in the embodiment of Fig. 15 substantially around the inner periphery of the circular wall except at a lower portion thereof. The ducts 56 are connected to the air conditioning unit 55 in a closed circuit system such that cold air flowing into the ducts 56 from the unit 55 is returned to the unit 55 for re-cooling.

In the embodiment of Fig. 14, planar panels 57 are supported adjacent the side and top walls of the chamber 54 and outwardly of the ducts 56. The panels 57 support sets of downwardly angled condenser panels or plates 58 upon which moisture will condense from air flowing into the chamber 54. The condenser panels or plates, however, may be arranged in many different orientations. The chamber 54 additionally includes sets of upper air inlet ducts 59 at one end of the chamber 54 and sets of lower air outlet ducts 60 at the opposite end of the chamber 54. The base of the chamber 54 may be provided with a trough-shaped water collection panel 61 which directs water to an outlet 62 for distribution to a storage location or for use.

In the embodiment of Fig. 15 in which like components to those of Fig. 14 have been given like numerals, angled condenser plates 58 are supported on a part cylindrical panel 63 arranged coaxially within the cylindrical chamber 54 and outwardly of the cooling ducts 56. The air inlet ducts 59 in each embodiment may be angled to create a spiral inlet flow through the chamber 54.

In use, the chamber 54 is inclined to the horizontal such that the water outlet 62 is located lowermost. In this attitude, convection air flows through the chamber 54 from the air inlets 59 to the outlets 60 which will also promote condensation of moisture on the plates or panels 58. This is further encouraged by the cooling effect of the cold air flowing through the ducts 56 adjacent the plates or panels 58. Moisture condensing on the plates or panels 58 will drip onto the collection panel 61 or the lower inner surface of the chamber 54 for passage to the water outlet 62.

Figs. 16-18 illustrate schematically the general configuration of the air cooling system wherein the outlet 64 from the air conditioning unit 55 supplies air to the multiple ducts 56 for passage along the chamber 54 with the air from the ducts 56 being returned at the inlet 65 to the air conditioning unit 55 for re-cooling.

Referring now to Fig. 19, there is illustrated a further form of moisture collection unit 66 according to an embodiment of the invention in which, in this instance, the condenser panels or plates 67 are of a conical configuration to defined downwardly angled condenser surfaces of approximately 45 degrees. The condenser panels or plates 67 are arranged at a spaced position along a central pole 68. The pole 68 may comprise a hollow tube and apertures 69 may be provided in the tube at spaced positions towards the apexes of

respective conical panels or plates 67. Moisture condensing on the panels or plates 67 flows down the surfaces of the panels or plates 67 and passes through the apertures 69 into the central tube for collection.

The condenser panels or plates 67 may typically be of the form shown in Fig. 20 being of circular cross-section, whilst in the embodiment of Fig. 21, the conical panels or plates 67 are provided with a series of apertures or slots 70 which allow for continuous air circulation through the unit 66. The conical panels or plates 67 may have any cross-section such as rectangular or square as shown in Fig. 22.

The units 66 may be arranged in any configuration, for example, in buildings 71 and 72 of circular or rectangular cross section as shown in Figs. 23 and 24. The building may also be of the form of the building of Fig. 3 with water passing through the central poles 68 being directed onto a base 29 for common collection of the water from all units 66. Such a building may also incorporate an air extraction system as previously described to ensure exhausting of dry air and replacement with moist air from the atmosphere. The building may also incorporate a closed circuit cooling system of the type described with reference to Figs. 10 to 16 to ensure efficient condensation of moisture on the panels or plates 67.

Typically, and as shown in Fig. 25, the conical panels or plates 67 may be constructed from a flat sheet 73 which may be folded into a circle to create the panel 67 with the overlapping ends then being joined, for example, along the dotted line in Fig. 25 by welding such as spot welding, by fasteners or other connection arrangement. Formed conical panels 67 may then be slid over the pole 68 and annular collars 74 provided between each panel 67 to set the spacing between the panels 67 and form the assembled unit 66.

In each of the above described systems, the condenser plates may be at steeper or less steep angles from that described. The moisture collection systems as described above may be provided in various sizes and may be made portable for various uses or erected on site in larger installations for supplying water to communities or for agricultural purposes. To avoid costs of pumping, the systems may be erected at an elevated location such as on mountains so that the collected water can be supplied by a gravity supply system. The extent of collection of water may be governed so that collection tanks or other storage devices are not required. Other benefits of the systems are that they would allow development of areas normally regarded as marginal such as deserts and also allow for rebuilding of underground water supplies.

Each of the described systems may incorporate air extraction fans or other means to increase air flow through the space containing the condenser members. Each system may also incorporate means to cool air within the space such as the described closed circuit air conditioning system. Each system may also include humidity control means which allows, or causes by the use of fans, for example the air extraction fans, greater air flow through the condenser space when humidity drops. Associated with the humidity control means may be a temperature control means which will prevent hot air flowing through the condenser space. Each system may be further adapted such that any exhausted cool air is recycled to pre-cool the subsequent incoming air.

Flow through the condenser space may be maximised by venturis or funnels at the upper end of the condenser space to slightly pressurise the condenser space and induce flow through the space. Pitot tube extraction may be used at the lower end of the condenser space to allow extraction of used dry air and its replacement by new incoming humid air.

It will be appreciated that the above described embodiments are only exemplification of the various aspects of the present invention and that modifications and alterations can be made thereto without departing from the inventive concept as defined in the following claims.